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71 Applicant: Coopers Filters Limited  
20 St Mary's Parsonage  
Manchester M3 2NL(GB)

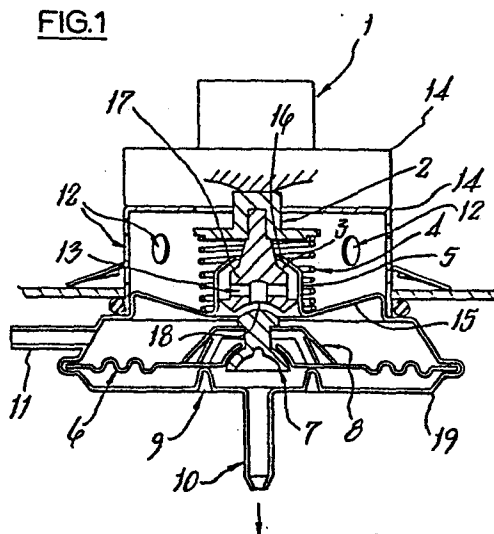
72 Inventor: Gladstone, Robert Steuart  
123 Croesnonen Park  
Abergavenny Gwent(GB)

74 Representative: Crux, John Anthony et al,  
P.O. Box 20 Ashburton Road West Trafford Park  
Manchester M17 1RA(GB)

54 Air temperature control device for the intake air of an engine.

57 An air temperature control device for the air intake of an internal combustion engine comprises a thermo-responsive actuator which is, in use, disposed to respond to the air temperature in said intake system, a first valve means operably connected to the actuator for progressive movement in a first chamber provided with air inlet and/or outlet ports between two positions, in the first of which positions a first bleed passage from the chamber is closed and in the second of which positions said first bleed passage is open permitting the passage of air to or from said ports from a second chamber provided with an air inlet which is connected in use to a vacuum motor operable to adjust the relative proportions of ambient and pre-heated air admitted to the intake system, and a second valve means to close said bleed passage and also operable to close a second bleed passage between said second chamber and a third chamber having a port which is connected (in use) to a vacuum source constituted by the air intake manifold of the engine, said second bleed passage being defined in pressure responsive wall member separating said second and third chambers.

**FIG.1**



- 1 -

TITLE MODIFIED  
see front pageImprovements in and relating to Air FiltrationBACKGROUND

5 This invention relates to air temperature control  
devices for internal combustion engines. Such devices  
are well-known; they are used in an attempt to provide  
the engine air intake with air at a temperature  
appropriate to the operating conditions prevailing at a  
particular time. These operating conditions include  
such parameters as throttle setting, engine temperature  
10 and ambient air temperature.

BRIEF DESCRIPTION OF THE PRIOR ART

Air temperature control devices together with some  
preferred operational features are described in for  
example Patent Specifications GB1126157, GB1313434 and  
15 GB1361728. Thus it is known to use bimetallic strips  
and other thermo-responsive devices to actuate air  
valves of various kinds, either directly or through a  
servomotor. In particular, it is known to adjust the  
relative proportions of ambient air and pre-heated air  
20 to reflect the engine temperature and the ambient air  
temperature, especially under "cold start" conditions.

OBJECTS OF THE INVENTION

It is an object of the present invention to provide an air temperature control device having improved operating characteristics. It is a further object of the invention to provide an engine air intake system fitted with the device.

BRIEF DESCRIPTION OF THE INVENTION

According to the present invention an air temperature control device for the air intake system of an internal combustion engine comprises a thermo-responsive actuator which is, in use, disposed to respond to the air temperature in said intake system, a first valve means operably connected to the actuator for progressive movement in a first chamber provided with an air inlet and/or outlet ports between two positions, in the first of which positions a first bleed passage from the chamber is closed and in the second of which positions said bleed passage is open permitting the passage of air to or from said ports to or from a second chamber provided a port which is connected, in use, to a vacuum motor operable to adjust the relative proportions of ambient and pre-heated air admitted to the intake system, and a second valve means engageable with the first valve means to close said bleed passage, third valve means operable to close a second bleed passage between said second chamber and a third chamber having an air outlet connected, in use, to the engine air intake manifold, said second bleed passage being defined in a pressure-responsive wall member separating said second and third chambers.

PREFERRED FEATURES OF THE INVENTION

5 The pressure responsive wall member is preferably a diaphragm and the second valve means is preferably a poppet valve mounted thereon and biased so as to close said second bleed passage, for example by means of a spring. The first valve means and the associated thermo-responsive actuator are preferably biased towards closure of the first bleed passage, with the actuator in its fully retracted cold state.

10 The air temperature control device is preferably provided with means for limiting the movement of the pressure responsive wall member in the direction of the air outlet.

15 The air outlet from the third chamber preferably incorporates a restriction, the purpose of which is to ensure that there is still a pressure drop when the actuator has opened the first valve means. This pressure drop serves to create a pressure intermediate that in the first chamber and that due to the vacuum source, namely the engine vacuum at the carburettor throat. The restriction may be achieved by selection of pipe size and/or length, but it will usually be more convenient to include a conventional narrow orifice, at the point of connection to the sensor, for example.

25 DESCRIPTION OF SPECIFIC EMBODIMENTS OF THE INVENTION

In order that the invention be better understood a particularly preferred embodiment of it will now be described by way of example with reference to the accompanying drawings in which:-

30 Figure 1 is a cross-sectional side view, of an air temperature control device according to the invention.

Figure 2 is a diagrammatic side view, partly in section, of an internal combustion engine air intake system embodying the device of figure 1.

5        Figures 3 to 8 inclusive are diagrammatic illustrations of the device of figure 1 in conjunction with the vacuum motor of figure 2 when in use under various engine and ambient air temperatures and at different throttle settings.

10       Figure 9 is a temperature/displacement graph showing the preferred mode of operation of the thermo-responsive actuator portion of the device of figure 1.

15       Referring firstly to figure 1, the device comprises a thermo-responsive actuator 1 of the wax pellet type. This is seated on a housing 14 which constitutes the side wall of a first chamber provided with a plurality of ports 12. The first chamber is closed by a bottom wall 15 having a central tubular upstand 5 provided with an aperture 16 which constitutes a first bleed passage from the chamber.

20       The actuator 1 has a piston 2; a compression spring 4 biases the latter away from the bottom wall 15 towards its fully retracted state. The piston carries a bleed valve member 17 which extends into the tubular upstand 5 and has a sealing surface 3 adapted to seat against the rim of the upstand when the actuator is fully retracted.

25       Air bleed passageways 13 extend through the member 17 and communicate with a downwardly facing port 18 located in a second chamber constituted by a peripheral flange portion of the wall 15 and a diaphragm 6. The central area of the latter is provided with an aperture

30       containing the lower portion of a non-return poppet

value 7 biased by a spring 8 to close the aperture. The second chamber has also a vacuum motor pipe connection port 11. The upper portion of the poppet valve is of complementary shape to that of the downwardly facing port 18 in the bleed valve member 17. A third chamber 18 is constituted by a bottom plate 19 crimped around the peripheral portions of the wall 15 and the diaphragm 6 to hold the assembly together. The bottom plate has an air outlet pipe 10 and an annular recess 9 which serves to limit the extent of movement of the centre of the diaphragm 6 towards the bottom wall. In the interests of clarity the sensor has been deliberately shown in figure 1 with the actuator 1 in a partially-operated state.

Referring now to figure 2, the device of figure 1 is mounted with the actuator 1 inside an internal combustion engine air intake passage 21 between the throttle valve 22 of a carburettor 23, and an air cleaner 24. The air cleaner is supplied with air from two sources, one a source of pre-heated air, 25, the other a source of ambient air, 26.

A vacuum servomotor 27 is provided to operate a flap valve 28 which enables the relative proportions of air from the two sources to be adjusted between the extremes of all hot pre-heated air and all-ambient temperature air. The vacuum motor is connected by a pipe 29 to the pipe connection 11 of figure 1. The air outlet pipe 10 of figure 1 is connected to a vacuum source constituted by a pipe 30 tapped into the carburettor throat downstream of the throttle valve 22.

Referring now to figures 3 to 8 inclusive, these show the system of figure 2 at various engine/ambient temperatures, with throttle settings in the closed (over-run) to partially open range and also under full throttle conditions. Taking the figures in turn, figure 3 is the completely cold start condition. There is a relatively high vacuum in the throat 31; this pulls the diaphragm firmly down onto the apex of the recess 9 and opens the poppet valve 7. Because the actuator is fully retracted, the bleed valve member 17 sealing surface 3 is seated against the rim of the upstand 5 and the reduced pressure in the second chamber is applied only to the servomotor 27 through the pipe connection 11. The servomotor moves the flap valve 28 to close off the ambient source 26, so that all intake air is drawn from the pre-heated source 25. In figure 4, application of full throttle to the cold system (25°C) reduces the vacuum in the third chamber 18 and allows the poppet valve 7 to close. The reduced pressure thereby trapped in the second chamber lifts the diaphragm upwardly off the apex of recess 9 until the upper portion of the poppet valve hits the margins of the downwardly facing port 18 in the bleed valve member 17. This momentarily unseats the poppet valve and allows at least some equalisation of the pressures above and below the diaphragm before the poppet valve seats again.

The stiffness against upward movement of the diaphragm 6 gives the sensor the characteristics of a pressure regulator under full throttle conditions. The final pressure differential across the diaphragm will be a function of the clearance between the lower margin of port 18 and the lower (rest) position of the poppet valve 7; it will therefore vary inversely with the degree of extension of the actuator 1.

However, the net effect is a slight reduction in the vacuum applied to the servomotor so that some ambient air is allowed to enter the intake to increase engine power.

5 In figure 5 the device is as depicted in the partially warmed-up condition achieved when pre-heated air has caused the actuator 1 to operate, pushing the piston and bleed valve member 17 down against the spring 4. The sealing surface 3 unseats from the rim of  
10 the upstand 5, allowing air to bleed into the second chamber from the intake passage via ports 12, 13 and 18. This further reduces the vacuum developed under light (or closed) throttle conditions and the servomotor admits more ambient air. The cooling effect of the  
15 latter on the actuator 1 is such that the position of the actuator will depend very largely on the ambient temperature, once the system is thoroughly warmed up. Thus at low (cold) ambient temperatures (typically below 7 °c) very little ambient air is needed to maintain a  
20 desired air intake temperature of say 25 to 30 °c. The higher the ambient temperature, the greater the proportion of ambient air needed to achieve/maintain the desired air intake temperature, of course.

25 In figure 6, still only partially warmed-up, or when the ambient temperature is low (say 7°C), the full throttle condition is very much as in figure 4, but because the actuator has started to operate, the diaphragm need not lift as far to momentarily unseat the poppet valve. However, at the same time, the upper  
30 portion of the poppet valve will close the port 18, thereby preventing the entry of air from ports 12 into the second chambers. The reduction in the vacuum applied to the servomotor will however be somewhat greater, due to the regulating action of the diaphragm 6 and the poppet valve 7.



Accordingly, more ambient (cold) air will be allowed into the intake, but not so much that carburettor icing occurs.

5 When the engine is warm and the ambient air temperature is high, the actuator is fully operated as shown in figure 7 and the vacuum in the second chamber is minimal, so that the servomotor hardly operates. The air intake is therefore predominantly all at ambient temperature. Under the figure 8 full throttle condition  
10 the diaphragm has only to rise very slightly to unseat the poppet valve, so that the increase in pressure (fall in vacuum in the throat 31) is communicated to the servomotor, ensuring that the latter closes off the pre-heated air source to give maximum engine power by  
15 virtue of admitting only ambient air to the air cleaner.

Figure 10 shows the actuator movement as a function of temperature corresponding to the three conditions (1,2 and 3 on the graph) represented by the three pairs of  
20 figures, namely figures and 4, 5 and 6 and 7 and 8 respectively.

What we claim is:-

1 An air temperature control device for the air intake  
of an internal combustion engine characterised in that  
said device comprises a thermo-responsive actuator which  
5 is, in use, disposed to respond to the air temperature in  
said intake system, a first valve means operably  
connected to the actuator for progressive movement in a  
first chamber provided with air inlet and/or outlet  
ports between two positions, in the first of which  
10 positions a first bleed passage from the chamber is  
closed and in the second of which positions said first  
bleed passage is open permitting the passage of air to  
or from said ports from a second chamber provided with  
an air inlet which is connected, in use,  
15 to a vacuum motor operable to adjust the relative  
proportions of ambient and pre-heated air admitted to  
the intake system, and a second valve means to close  
said bleed passage and also operable to close a second  
bleed passage between said second chamber and a third  
20 chamber having a port which is connected (in use) to a  
vacuum source constituted by the air intake manifold of  
the engine, said second bleed passage being defined in a  
pressure responsive wall member separating said second  
and third chambers.

2 A control device according to claim 1 characterised  
in that the first valve means and the  
pressure-responsive wall member is a diaphragm and the  
second valve means is a poppet valve mounted thereon and  
biased so as to close said bleed passage.

3 A control device according to claim 1 or claim 2  
characterised in that the first valve means and the  
thermo-responsive actuator are biased towards closure of  
the first bleed passage with the actuator in a fully  
retracted, cold state.

4      A control device according to any preceding claim characterised in that the actuator is a wax pellet device.

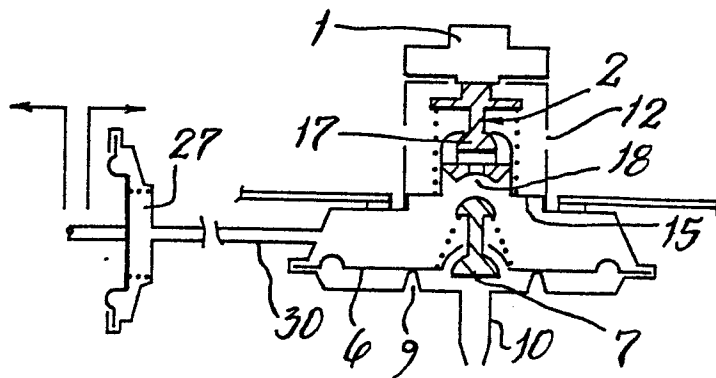
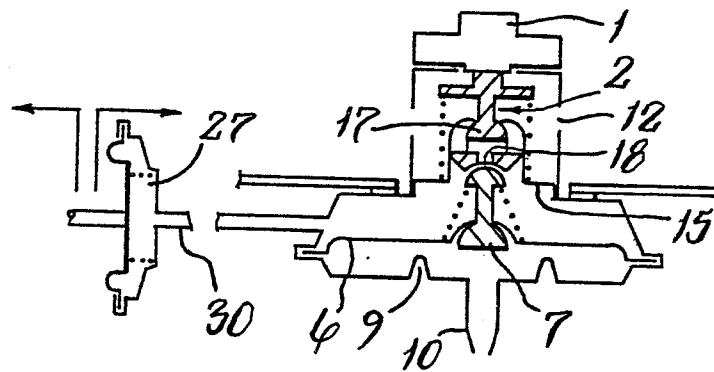
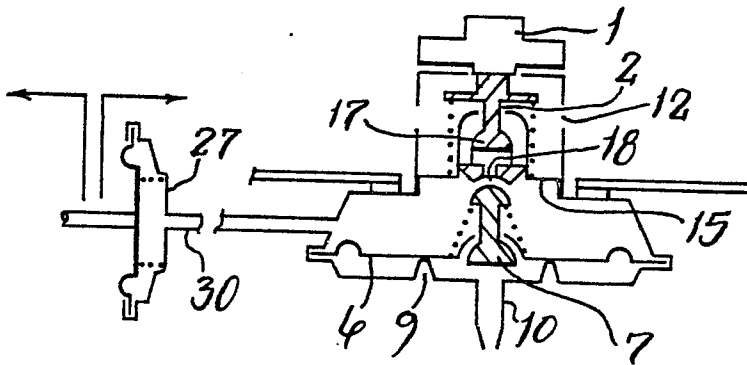
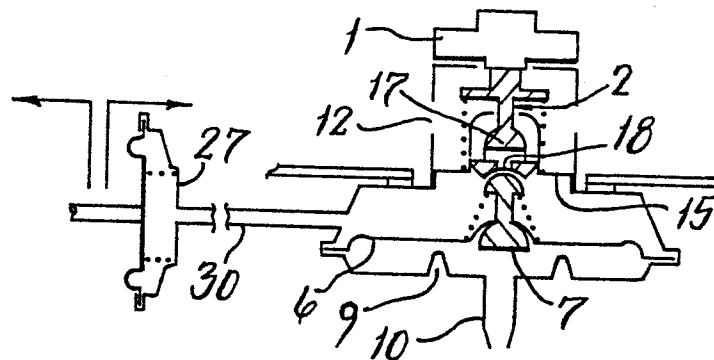
5      A control device according to any preceding claim characterised in that the actuator is substantially fully retracted below about 10 °c.

6      A control device according to any preceding claim characterised by the provision of means for limiting the movement of the pressure responsive wall member in the direction of the port connected to the vacuum source.

7.     A control device according to any preceding claim characterised in that the port is connected to the vacuum source through a restriction whereby an intermediate pressure is created between that in the first chamber and that of the vacuum source.

8.     The use of the control device of any of claims 1 to 7 in an internal combustion engine air intake system.



FIG. 3FIG. 4FIG. 5FIG. 6

